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## Notes on Chilean Anapids and Their Webs

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### ABSTRACT

Orb webs of the Chilean anapid genera *Crassanapis* Platnick and Forster, *Sheranapis* Platnick and Forster, and *Elanapis* Platnick and Forster are described for the first time. *Crassanapis* and *Sheranapis* species spin a typical anapid web, with one to several radii above the orb-plane, going upward from the hub. Their webs are intraspecifically variable in size and architectural details. *Sheranapis villarrica* Platnick and Forster often constructs smaller webs close to the water surface of streams. The web of *Elanapis aisen* Platnick and Forster is two dimensional, without orb-plane threads, like typical webs of Symphytognathidae. The webs of *Minanapis* species are still unknown. *Elanapis aisen* has a protruding labrum, which supports its placement in Anapidae. The spinnerets of *Elanapis aisen* and *Crassanapis chilensis* are figured and described. The respiratory system of *Elanapis aisen* and *Minanapis floris* is described; all Chilean anapids examined so far have normal booklungs and four simple tracheae limited to the abdomen.

### INTRODUCTION

Orb webs and their associated behaviors comprise the largest set of synapomorphies defining the group Orbiculariae (e.g., Eber-

hard, 1987; Coddington, 1990; Griswold et al., 1998), which includes two superfamilies, Deinopoidea and Araneoidea. Both make use of special, adhesive threads to tangle or stick prey in the web. The cribellate deinopoids

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use dry, cribellar threads, similar to those used by other cribellate spiders, while the ecribellate araneoids use viscid adhesive threads composed of dry, axial fibers coated with a sticky aqueous solution, disposed in characteristic droplets, which are evenly spaced along the thread (e.g., Peters, 1987; Opell, 1997; this paper, fig. 27).

Typical anapid webs, and those of the mysmenid *Maymena* Gertsch, are well known for having additional radii and sticky spirals, above the plane of a horizontal orb (Coddington, 1986; Eberhard, 1987; Platnick and Forster, 1989). However, the webs of most anapid genera are still undescribed. There is positive evidence of nonorbicular webs for only two species of anapids. The European *Comaroma simoni* Bertkau builds a small, quite irregular web with long threads with sticky ends running towards the substratum, resembling a theridiid web (Kropf, 1990). This small web seems well suited to their cryptic dwelling in deeper layers of leaf litter. The Chilean *Sofanapis antillanca* Platnick and Forster is a kleptoparasite of austrochiline spiders, and does not make its own capture web (Ramírez and Platnick, 1999), but only an irregular mesh superimposed on the host's sheet web (MJR and LL, personal obs.). In addition to these, if Micropholcommatidae were a derived clade nested within anapids (Schütt, 2002), then *Micropholcomma* and *Textricella* should be added to the list (Hickman, 1944, 1945; Forster, 1959). We present here the first documentation of orb webs in the Chilean anapid genera *Sheranapis* Platnick and Forster, *Crassanapis* Platnick and Forster, and *Elanapis* Platnick and Forster.

## MATERIALS AND METHODS

Most observations and collections were made in December 1998 in Parque Nacional Puyehue, and Monumento Natural Contulmo, two intensively collected localities of Valdivian temperate forest. Most specimens for this study were collected by detecting the tiny webs with the aid of a cornstarch puffer (Carico, 1977) and a flashlight. Webs were powdered with cornstarch for photography, illuminated with a speedlight from above or the side. Manual collections were comple-

mented with extensive processing of leaf litter, concentrated with sifters of 5 mm or 10 mm mesh, then processed in Moczarzsky-Tullgren extractors similar to those described by Wheeler and McHugh (1987; also similar to Berlese funnels and Winkler devices). Each extraction was made for one day (overnight) in the field, without any heat source except for variable amounts and times of direct sunlight. Before filling the extractors, most of the concentrated litter was inspected on a white background and some individuals collected manually. Specimens are deposited in the Museo Argentino de Ciencias Naturales (MACN-Ar) and Museo Nacional de Historia Natural de Chile, Santiago (MHNS). Vouchers for photographs are labeled with acronyms of collector, date, and a sequential number, followed by frame number as it appears in the film (e.g., MJR-15.XII.98/4, fotograma 9). The photographic slides have the same information.

Webs were sampled with standard microscope slides and strips of vinyl flooring tiles coated with contact glue, forming a rectangle, to keep the web from contacting the glass. Just before sampling, the rectangle is glued with contact glue. Slides were observed with a compound microscope and stored in regular boxes for microscopic preparations. The presence of adhesive droplets of sticky silk was confirmed with a compound microscope only for the orb-plane spirals; stickiness of above the orb-plane spirals was only confirmed sporadically, gently probing with the tip of a mechanical pencil (no records for those). Labeling is the same as described for photographs.

Tracheae were examined after digestion of tissues with 10–20% KOH solution at 100°C in a double boiler. Structures were critical point dried for scanning electron microscopy, sputter coated, and observed with a Hitachi S4700 FE-SEM under 7–10 kV, except native sticky silk samples, observed under 1 kV.

## RESULTS

The three observed species of *Crassanapis* and *Sheranapis villarrica* Platnick and Forster all construct typical anapid webs, with one to four above the orb-plane radii (APR)

going upward from the hub, planar sticky spirals, and above the orb-plane sticky spirals. Some variability occurs in the number of APR and planar sticky spirals, as well as in web size, and presence or number of supplementary radii (= accessory radii, the radii not specifically connected to the sticky spiral). Specific comments are detailed below for each species. The webs of *Elanapis aisen* Platnick and Forster are atypical for anapids, seemingly identical to those of some Symphytognathidae. Those of *Minanapis* Platnick and Forster are still unknown.

*Crassanapis chilensis* Platnick and Forster

Figures 1, 2, 11–18

**WEB:** These relatively large anapids often construct large webs of about 7 cm diameter and 10 cm height (figs. 1, 2). Most often there are two APR. A male and a female were collected together on the same web. Adult males or females were routinely collected as the only occupants of normal orb-webs.

**MORPHOLOGICAL REMARKS:** Spinnerets (figs. 11–18): Anterior lateral spinnerets with one spigot and one nubbin of major ampullate glands, and 11–13 (male) or 12 (female) piriform gland spigots. Posterior median spinnerets with one spigot and one nubbin of minor ampullate glands, and two aciniform gland spigots, female with a large anterior cylindrical gland spigot in addition. Posterior lateral spinnerets with one flagelliform gland spigot and two aggregate gland spigots in a triad, and two aciniform gland spigots, female with two cylindrical gland spigots in addition, one of them marginal, separated by a furrow from the rest of the spinning field.

**NEW RECORDS: ARGENTINA: Neuquén:** Parque Nacional Lanín: Lago Queñi, 15.II.1996, M. Ramírez 3♂ 2♀ 4juv. (MACN-Ar); Parque Nacional Nahuel Huapi: Lago Espejo, 5.I.1998, M. Ramírez, 1♂ 2♀ 7juv. (MACN-Ar); Puerto Blest, 10.I.1998, M. Ramírez 2♂ 1♀ 1juv. (MACN-Ar). **CHILE: Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, Moczarski-Tullgren extractor, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 3♀ (MACN-Ar), 1♂ 4♀ (MHNS). **Región X (Los Lagos): Osorno:**

Parque Nacional Puyehue: Aguas Calientes, 13–17.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 6♀ 1juv., 1♂ 1♀ collected on the same web, 1♂ MJR 15.XII.98/1 (2 APR, photo frames 17–21), 2♂ 4♀ (Moczarski-Tullgren extractor; MACN-Ar, one male and one female mounted for scanning, preparation MJR 677), 1♂ 3♀, 1♂ 3♀ (Moczarski-Tullgren extractor; MHNS).

*Crassanapis cekalovici* Platnick and Forster

Figure 3

**WEB:** Only one web was photographed (fig. 3), with at least two APR.

**NEW RECORDS: CHILE: Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1♀ MJR 19.XII.98/4 (many planar spirals, photo frame 9), 5♂ 1♀ (Moczarski-Tullgren extractor; MHNS).

*Crassanapis contulmo* Platnick and Forster

Figure 4

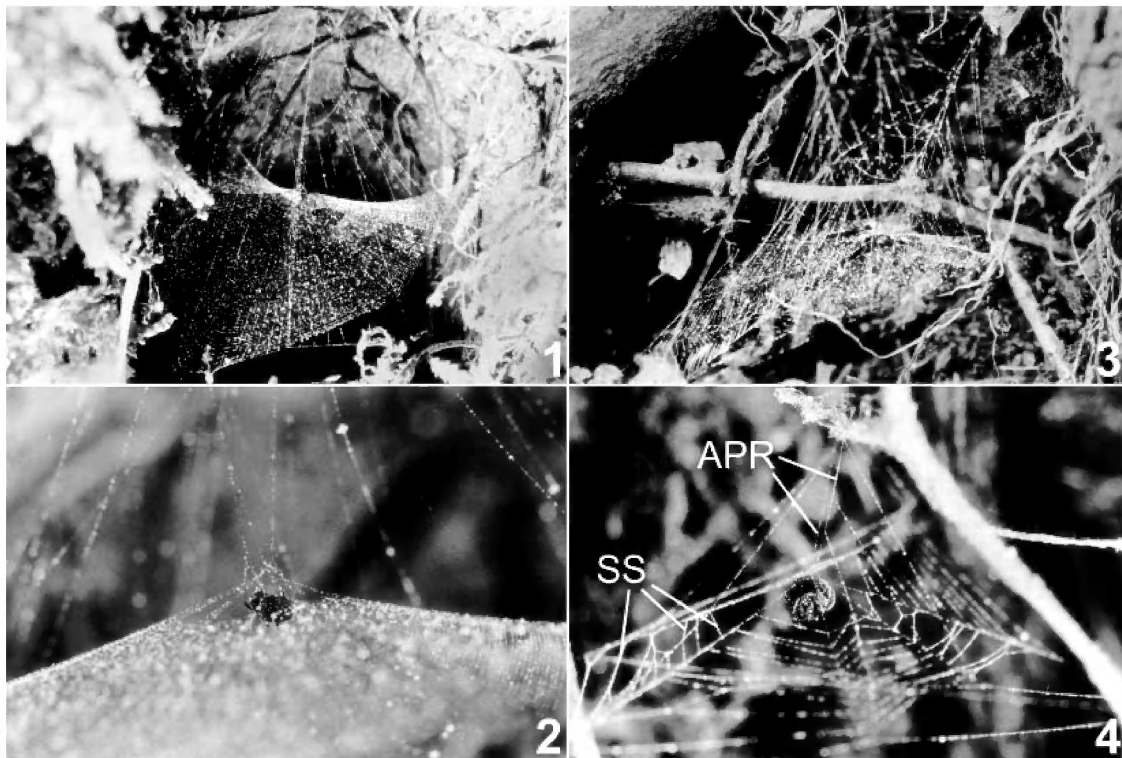
**WEB:** We have seen several large webs like those of *C. chilensis*, and some smaller ones, lacking supplementary radii (fig. 4) but with APR, commonly found in small cavities. In these small webs some of the spirals were collapsed, appearing widely spaced.

**NEW RECORDS: CHILE: Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 2♀ 3juv., 1♀ MJR 19.XII.98/3 (many planar spirals, photo frame 8), 1♀ MJR 19.XII.98/5 (many planar spirals, photo frame 10), 1♀ MJR 20.XII.98/9 (2 APR, planar spirals collapsed, looking widely spaced, photo frames 35–37), 4♂ 1♀ (Moczarski-Tullgren extractor; MACN-Ar), 2♂ 1♀, 4♂ 1♀ (Moczarski-Tullgren extractor; MHNS).

*Sheranapis villarrica* Platnick and Forster

Figures 5–8

**WEB:** These relatively large anapids are extremely common in Contulmo. Most specimens were collected along small streams. Adult males (fig. 5) and females were routinely collected as the only occupants of nor-

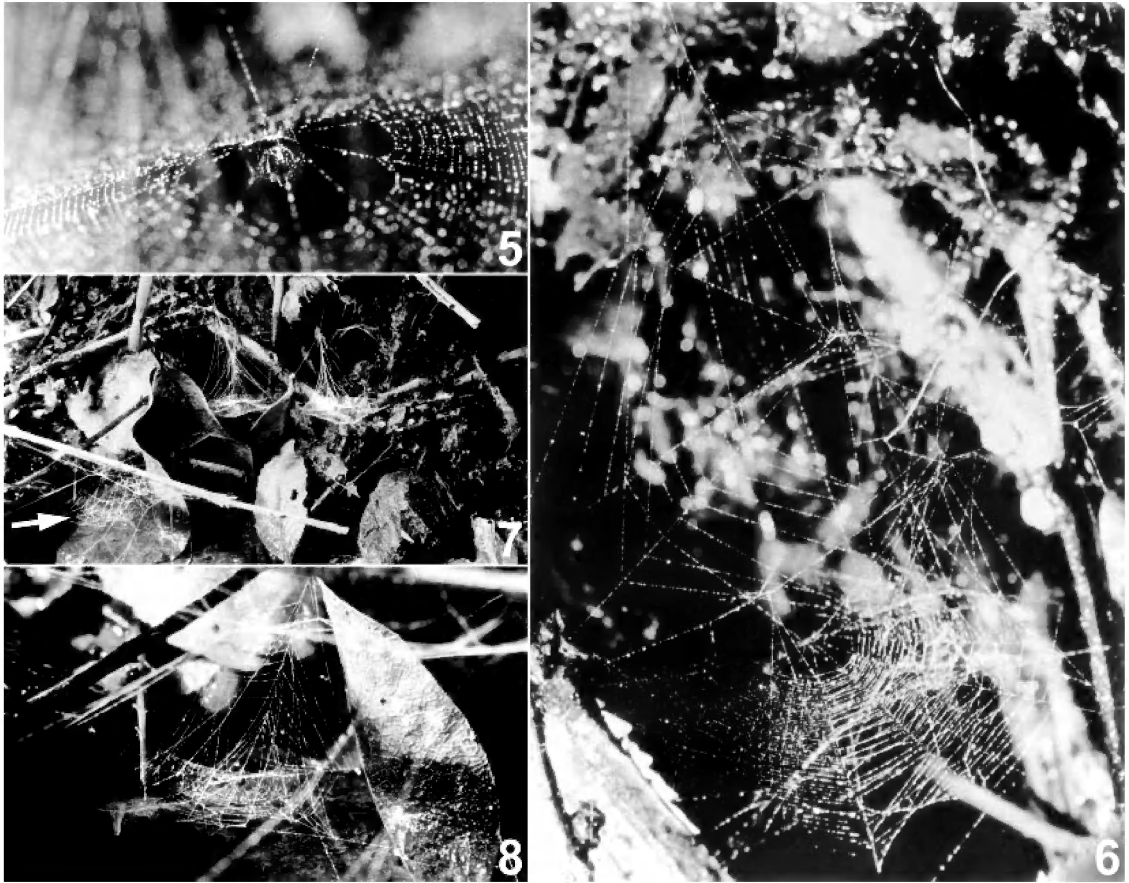


Figs. 1–4. Webs of *Crassanapis* species. 1. *C. chilensis* Platnick and Forster, male MJR 15.XII.98/1 from Puyehue. 2. Same, detail. 3. *C. cekalovici* Platnick and Forster, female MJR 19.XII.98/4 from Contulmo. 4. *C. contulmo* Platnick and Forster, female MJR 20.XII.98/9 from Contulmo; note the absence of supplementary radii (SS: sticky spirals on the orb-plane; APR: above the orb-plane radii).

mal orb-webs. Samples of one web from a male and one from a female showed normal sticky threads, with adhesive droplets. One male was seen on a modified web, attached to that of the female (fig. 6); it is not known whether the spirals of this web were sticky or not. The attached male's web was simpler, with evenly spaced spirals, no supplementary radii, and four APR going upward from the hub. Several webs were seen some millimeters above the water surface in small streams (figs. 7–8), with some of the threads in contact with the water. After powdering with cornstarch, some sticky spirals appeared immersed, but this could be an artifact from the air currents made in the powdering. One female was observed making the outer loops of sticky spirals. For each segment the spider moved all the way from the previous attachment point to the hub; thus no temporary spiral was made, as is known for other anapids (Eberhard, 1982: character state H3). These

aquatic webs tend to be smaller and simpler than the larger terrestrial webs, lacking supplementary radii.

NEW RECORDS: CHILE: **Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1♀ MJR 21.XII.98/6 (web on water surface, constructing sticky spiral, photo frames 30–31, damaged by powdering), 1♂ 1♀, MJR 20.XII.98/11 (male's web constructed on female's, photo frames 2–5), 1♀ MJR 21.XII.98/8 (2 APR, web on water surface, photo frames 33–36), 1♂ MJR 21.XII.98/5 (web sampled, poor condition), 1♂ MJR 21.XII.98/7 (web on water surface, photo frame 32), 1♂ MJR 20.XII.98/10 (1 APR, photo frames 0–1), 1♂ MJR 20.XII.98/8 (2 APR, many planar spirals, photo frames 27–34), 1♂ juv. MJR 19.XII.98/6 (2 APR, photo frames 11–12), 1♀ MJR 21.XII.98/4 (part of the web sampled, spirals adhesive, with



Figs. 5–8. Webs of *Sheranapis villarrica* Platnick and Forster, from Contulmo. **5.** Detail of large web of male MJR 20.XII.98/8. **6.** Modified web of male upon a female's web, MJR 20.XII.98/11; note the collapsed spiral segments on female's web, looking widely spaced. **7.** Sector of a stream showing the high density of anapid webs (arrow to aquatic web, the only one collected). **8.** Close-up of the aquatic web of Fig. 7, female 21.XII.98/8.

sticky balls), 3♂ 13♀ (MACN-Ar), 5♂ 15♀ (MHNS).

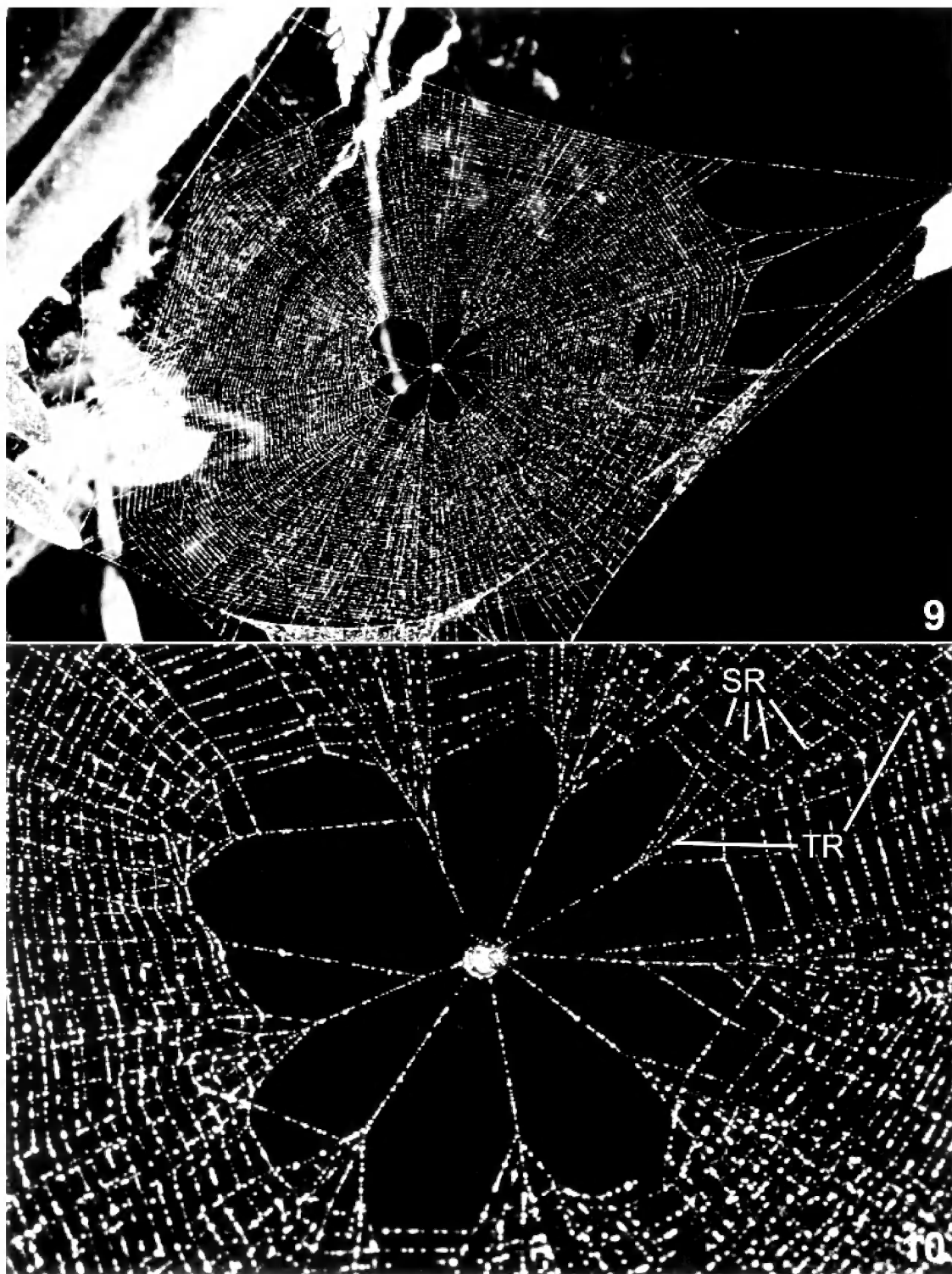
*Elanapis aisen* Platnick and Forster

Figures 9, 10, 19–31

**WEB:** These small anapids construct a planar orb web (figs. 9, 10) that seems indistinguishable from those of the symphytognathids *Patu* Marples (Forster and Platnick, 1977; Hiramatsu and Shinkai, 1993) and *Anapistula* Gertsch (Griswold et al., 1998). Two adult male webs sampled showed normal adhesive sticky threads, like those of females (fig. 27).

**MORPHOLOGICAL REMARKS:** Chelicerae free (fig. 19). Labrum with short but evidently

protruding spur (figs. 20–21). Median tarsal claws elongate, sinuous (fig. 22). Booklungs with a few, small unmodified lamellae. Tracheal spiracle in front of spinnerets, leading to four simple tracheae lined with spicules, limited to abdomen. Lateral tracheae very long, medians short, stiff, apex fibrous, seemingly muscle attachments. Major ampullate glands visible through translucent abdominal walls. Spinnerets (figs. 23–26, 28–31): Anterior lateral spinnerets with one spigot and one nubbin of major ampullate glands, and 8 (male) or 10 (female) piriform gland spigots. Posterior median spinnerets with one spigot and one nubbin of minor ampullate glands, and one aciniform gland spig-



Figs. 9–10. Web of *Elanapis aisen* Platnick and Forster, female MJR 15.XII.98/3 from Puyehue. **9.** Planar web. **10.** Same, detail of the hub (SR: supplementary radii; TR: true radius).

ot, female with a large anterior cylindrical gland spigot in addition. Posterior lateral spinnerets with one flagelliform gland spigot and two aggregate gland spigots in a triad, and two aciniform gland spigots, female with two cylindrical gland spigots in addition, one of them marginal, separated by a furrow from the rest of the spinning field.

NEW RECORDS: ARGENTINA: **Neuquén:** Parque Nacional Nahuel Huapi: Puerto Blest, 10.I.1998, M. Ramírez 4♂ 3♀ 8juv. (MACN-Ar); 7–20.I.2000, L. Lopardo and A. Quaglino, 6♂ 5♀ (MACN-Ar). **Chubut:** Parque Nacional Los Alerces: Lago Menéndez, Pto. Sagrario (wet forest with *Fitzroya cupressoides*), 29.II.1996, M. Ramírez 4♂ (MACN-Ar). CHILE: **Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1juv., 1♂ (MJR 20.XII.98/7, 9 hub radii, two opposing not totally collapsed, photo frames 22–25, on *Porteria* sp. web; MACN-Ar). **Región X (Los Lagos): Osorno:** Parque Nacional Puyehue: Aguas Calientes, 13–17.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1♀ MJR 15.XII.98/3 (8 hub radii, photo frames 29–33), 1♂ MJR 15.XII.98/4 (web sampled), 1♀ MJR 15.XII.98/5 (web sampled), 1♂ LL 15.XII.98/2 (web sampled), 1♀ MJR 16.XII.98/3 (photo frames 11–12), 1♂ 2♀ (Moczarski-Tullgren extractor), 4♂ 10♀ (MACN-Ar, one male and one female mounted for scanning, preparations MJR 40–43), 5♂ 11♀ (MHNS).

*Minanapis floris* Platnick and Forster

WEB: Not seen.

MORPHOLOGICAL REMARKS: Booklungs with a few small, unmodified lamellae, united by an interpulmonary canal. Tracheal spiracle in front of spinnerets, leading to four simple tracheae lined with spicules, limited to abdomen. Median tracheae short, stiff, with thin apex.

NEW RECORDS: CHILE: **Región IX (Araucanía): Malleco:** Mon. Nat. Contulmo, Moczarski-Tullgren extractor, 19–21.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1♂ (MHNS), 1♂ 1♀ (MACN-Ar). **Región X (Los Lagos): Llanquihue:** Frutil-

lar, Playa Maqui, I.1991, E. Maury, 1♀ (MACN-Ar).

*Minanapis palena* Platnick and Forster

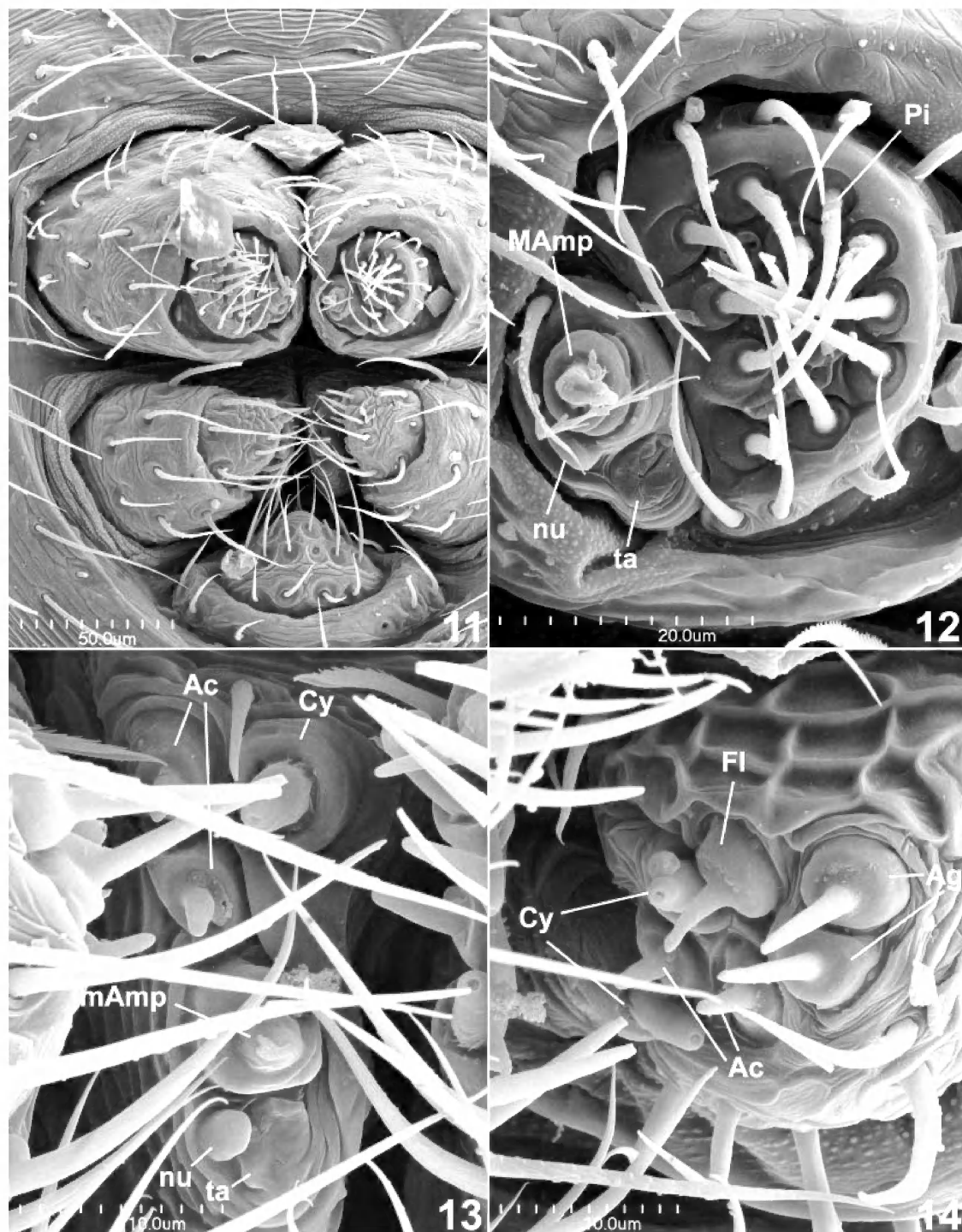
WEB: Not seen.

NEW RECORDS: CHILE: **Región X (Los Lagos): Osorno:** Parque Nacional Puyehue: Aguas Calientes, 13–17.XII.1998, M. Ramírez, L. Compagnucci, C. Grismado, L. Lopardo, 1♂ 1♀ (MHNS), 2♂ (Moczarski-Tullgren extractor; MHNS), 2♂ 1♀ 1juv. (Moczarski-Tullgren extractor; MACN-Ar).

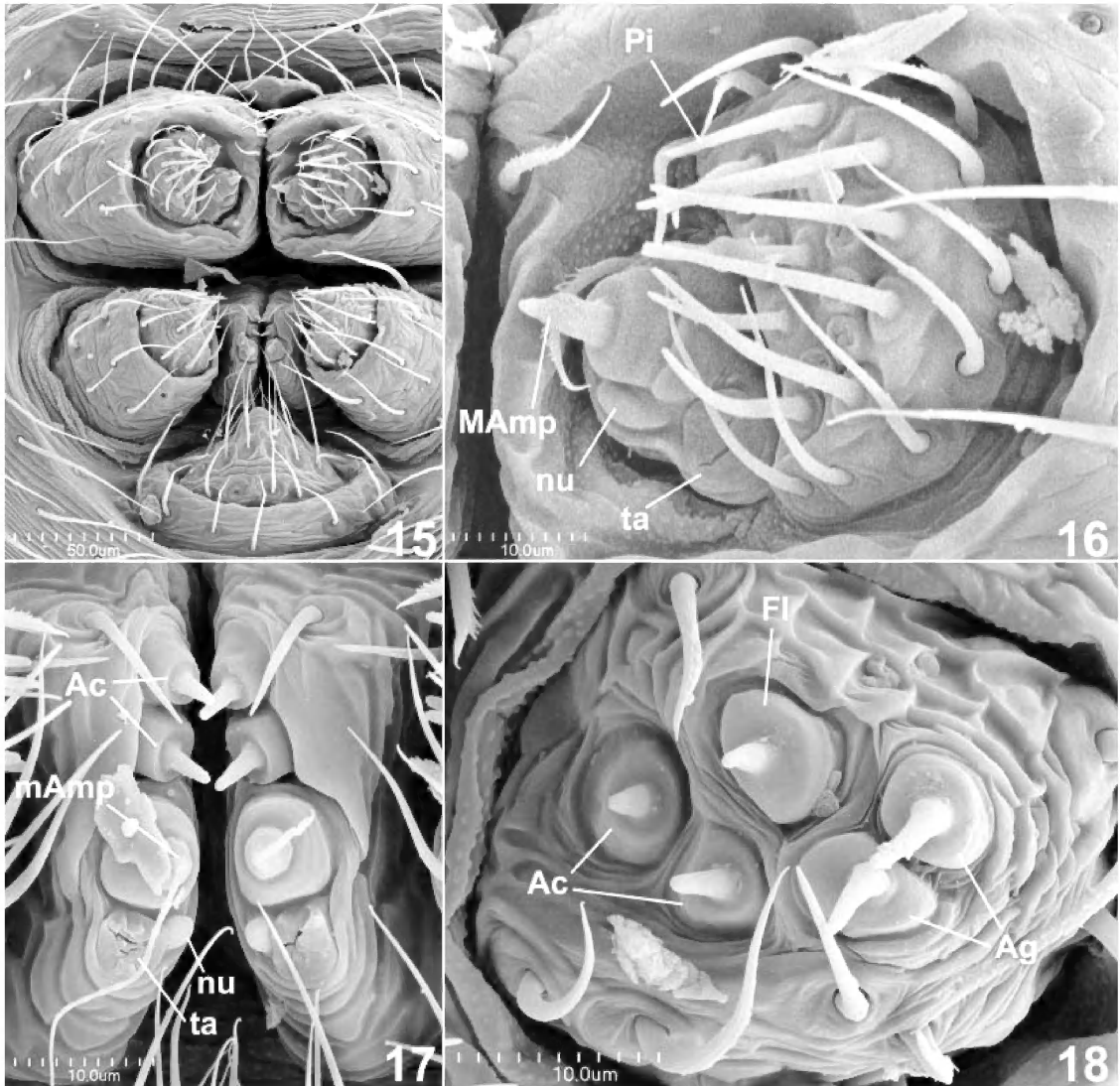
## DISCUSSION

The webs made by *Crassanapis contulmo* in small cavities and by *Sheranapis villarrica* on the water surface are often smaller, without supplementary radii. In both cases there seems to be some plasticity according to limited space and sparse attachment points. The aquatic webs made by *S. villarrica* are not so specialized as those of the Japanese anapid *Conculus lyugadinus* Komatsu (Shinkai and Shinkai, 1988), but still have a particular specialization: The orb is placed at a very short distance from the water surface, whereas terrestrial webs are never so close to the substrate. High variability in web architecture and building behavior was reported among individuals of the theridiosomatid genera *Wendilgarda* Keyserling and *Epilineutes* Coddington (Eberhard, 2000, 2001), which spin modified webs attached to water surface, as well as terrestrial webs. All this variability points out that some details of web architecture of phylogenetic interest (e.g., presence/absence of supplementary radii) would be better taken from several specimens rather than one or two.

Recent data on spigots and webs of araneoid spiders (Griswold et al., 1998; Hormiga, 2000, 2002; Eberhard, 2001; Schütt, 2002), as well as our results, show that the functional triplet that segregates the viscid sticky silk is much more often retained in mature males than previously thought. In other araneoids, the triplet is lost when males reach maturity (e.g., Coddington, 1989), and its retention seems clearly correlated with small adult size. Hormiga (2000) and Schütt (2002) have suggested that this pattern may be due to heterochrony, by the way of pre-



Figs. 11–14. *Crassanapis chilensis* Platnick and Forster, female spinnerets (inverted). **11.** Spinneret group. **12.** Right anterior lateral. **13.** Right posterior median. **14.** Right posterior lateral. Abbreviations used for gland spigots: Ac: aciniform; Ag: aggregate; Cy: cylindrical; FI: flagelliform; MAmp: minor ampullate; nu: nubbin of ampullate; Pi: piriform; ta: tartipore of ampullate.

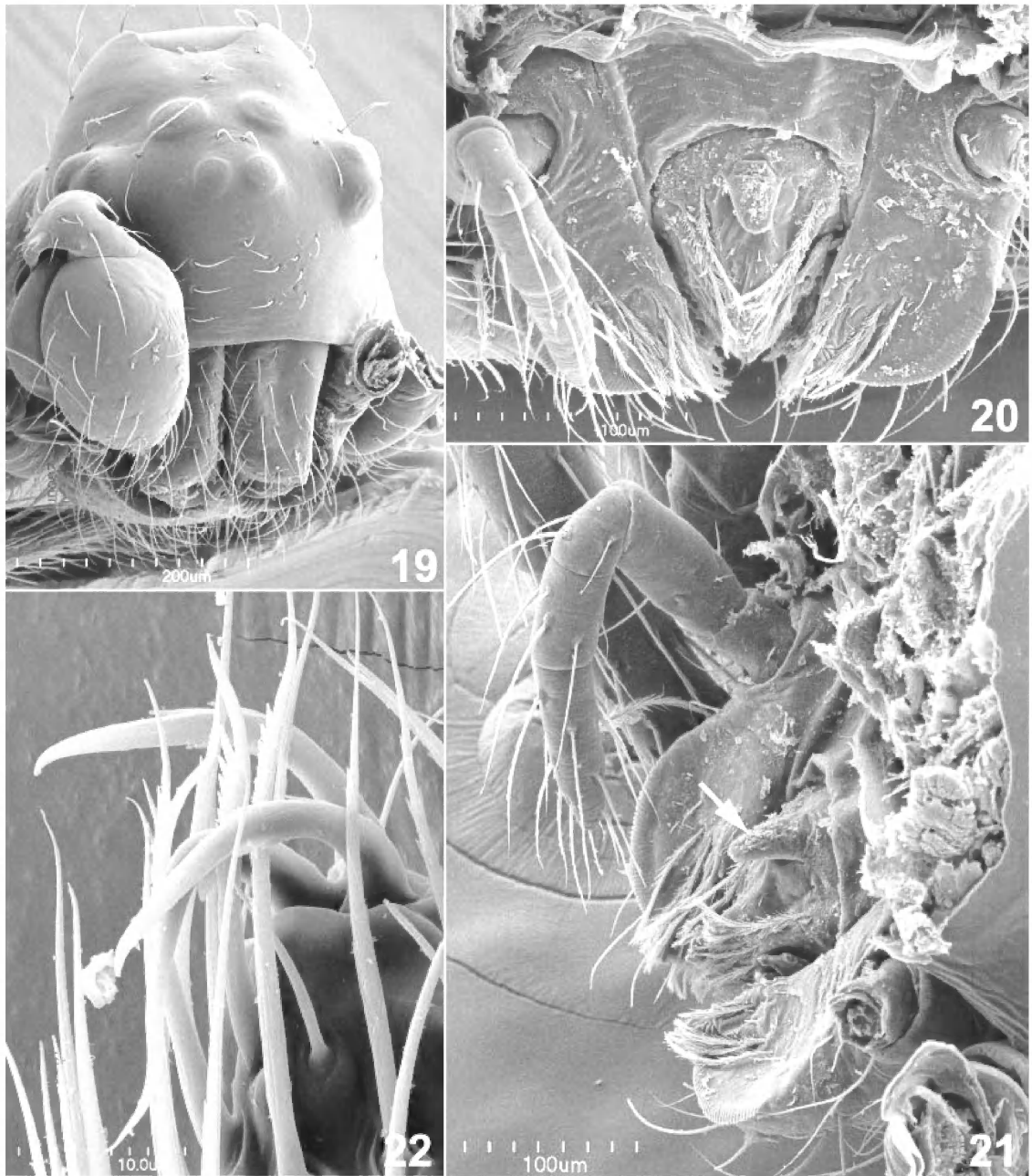


Figs. 15–18. *Crassanapis chilensis* Platnick and Forster, male spinnerets (inverted). **15.** Spinneret group. **16.** Right anterior lateral. **17.** Right posterior median. **18.** Right posterior lateral. Abbreviations as in Figs. 11–14.

cocious sexual maturation of juvenile males in several lineages independently. So far only one relatively large sized araneoid, the linyphiid *Orsonwelles malus* Hormiga, is known to retain the triplet in adult males (Hormiga, 2002). In addition to typical webs, at least some anapid males construct a special, simplified web upon that of the female. This was observed only once in *Sheranapis villarrica* (fig. 6), and many times in *Gertschanapis shantzi* (Gertsch) in a redwood forest in San

Mateo Co., California (11.VII.1998, MACN-Ar, MJR personal obs.). This behavior seems similar to that of the araneid *Mecynogea* Simon (Eberhard, 1977) and several uloborids (MJR and LL personal obs.), whose males also build webs on top of that of the female.

The planar webs of *Elanapis aisen* are atypical for anapids, and might suggest an alternative affiliation with symphytognathids. However, *Elanapis aisen* have a protruding labral spur, the only undisputed synapomor-

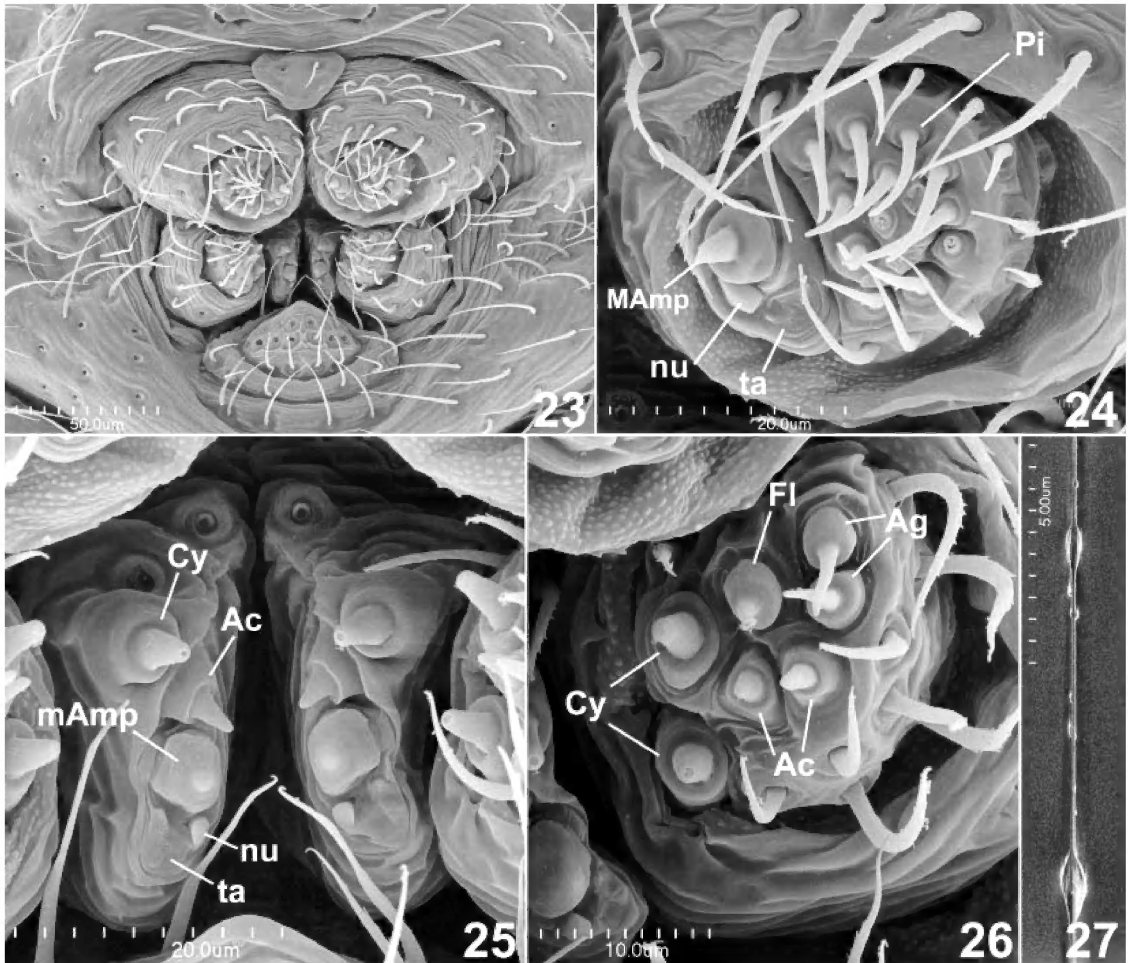


Figs. 19–22. *Elanapis aisen* Platnick and Forster. **19.** Male carapace, showing free chelicerae (broken on top). **20.** Female mouthparts, anterior view. **21.** Same, lateral, arrow to protruding labrum. **22.** Male, tarsal claws of left leg IV.

phy of anapids (Griswold et al., 1998; Schütt, 2002). These characters, and the plesiomorphic presence of female palp and anterior median eyes, make *Elanapis* an especially interesting taxon for a much needed phyloge-

netic analysis of symphytognathoid relationships.

According to Platnick and Forster (1989), some species of *Minanapis* are quite common, and we collected them during the



Figs. 23–27. *Elanapis aisen* Platnick and Forster, female spinnerets and sticky silk. **23.** Spinneret group. **24.** Left anterior lateral. **25.** Left posterior median. **26.** Left posterior lateral. **27.** Detail of sticky spiral. Abbreviations as in Figs. 11–14.

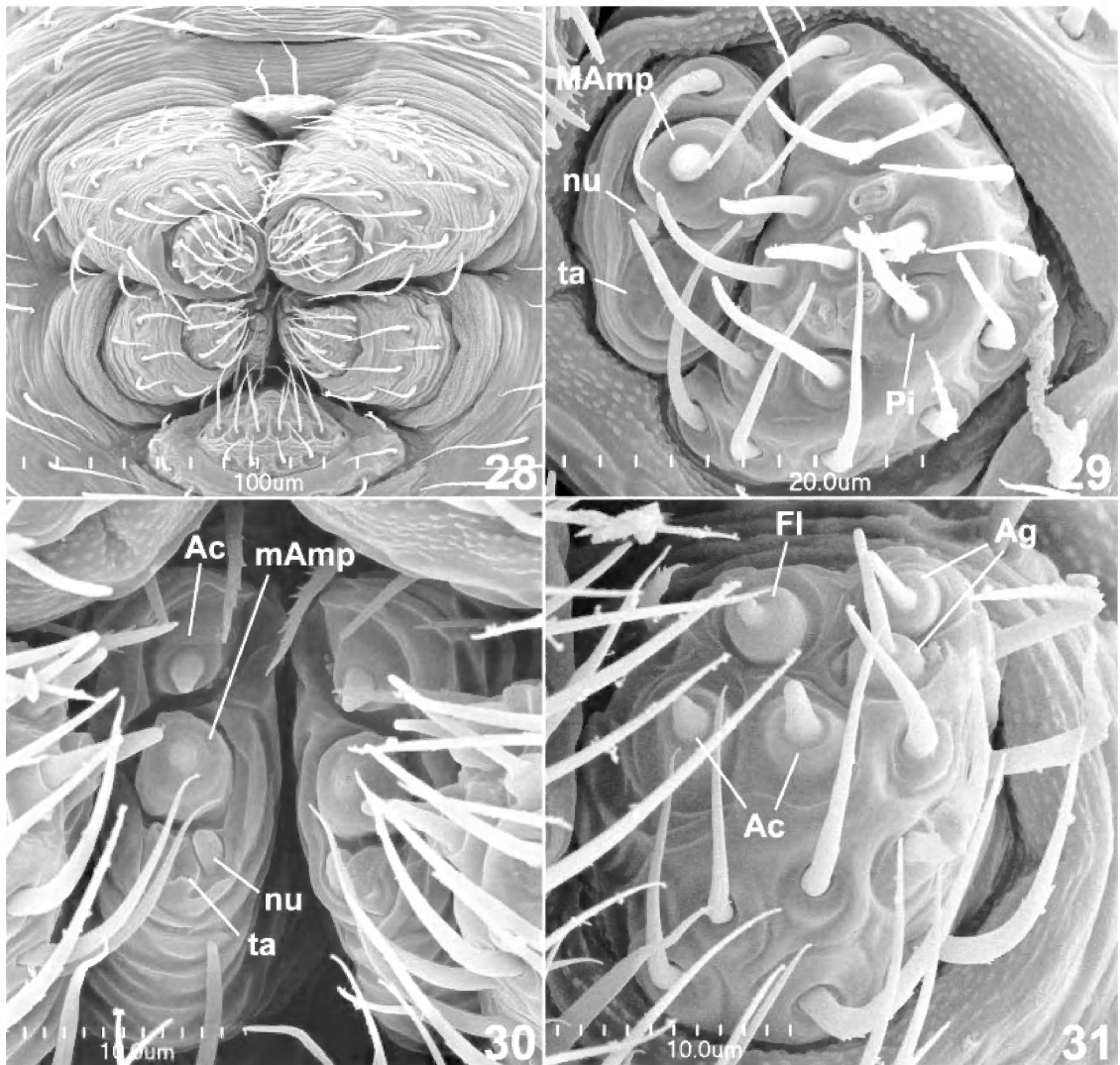
course of our study. Compared to the high density of other anapid webs, it is suggestive that we have not seen any *Minanapis* on a web, in localities where they appear in litter concentrates. These minute, armored anapids could well be adapted to life in small spaces in deeper layers of litter, and might spin modified webs, as occurs in *Comaroma simoni*, or not spin capture webs at all.

The typical orb webs and sticky spirals of *Crassanapis chilensis* are in conflict with their presumed lack of the PLS triplet (Platnick et al., 1991: figs. 293, 296). In the light of new knowledge of anapid spigot morphology, it seems evident that the flagelliform and aggregate gland spigots of anapids,

symphytognatids, and certain mysmenids (Griswold et al., 1998: figs. 27–37) are easily mistaken for aciniforms when observed with a scanning electron microscope, only differing by having a slightly longer and thinner shaft. *C. chilensis* have very similar spigot complements, as found in other anapids.

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Figs. 28–31. *Elanapis aisen* Platnick and Forster, male spinnerets (inverted). **28.** Spinneret group. **29.** Right anterior lateral. **30.** Posterior medians. **31.** Right posterior lateral. Abbreviations as in Figs. 11–14.

hard and Jonathan Coddington were especially helpful in discussing aspects of observation of spider webs. Brent Opell shared information on sampling and preserving webs. The Argentinean (APN) and Chilean (CONAF) National Park authorities provided assistance during field work. Luis Compagnucci and Cristian Grismado helped collect specimens in Chile. Different stages of this study were supported by funds TX024 and TW53 from the Buenos Aires University, a Sigma-Xi grant-in-aid of research (MJR and LL), a

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